

## **SECTION 15891 - METAL DUCTWORK**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes rectangular metal ducts and flexible connectors for ventilating systems in pressure classes from minus 2 inches to plus 2 inches water gage.

#### **1.2 DEFINITIONS**

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
  - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
  - 2. Joints: Joints include girth joints; branch and sub branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

#### **1.3 SYSTEM PERFORMANCE REQUIREMENTS**

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections, if required.
- B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
  - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
  - 2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
  - 3. Fittings.
  - 4. Reinforcing details and spacing.
  - 5. Seam and joint construction details.
  - 6. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Coordination drawings for ductwork installation in accordance with Division 15 Section "Basic Mechanical Requirements." In addition to the requirements specified in "Basic Mechanical Requirements" show the following:
  - 1. Spatial coordination with other systems installed in the same space with the duct systems.
- D. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

### **1.5 QUALITY ASSURANCE**

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- C. NFPA Compliance: Comply with the following NFPA Standards:
  - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise by the contract drawings.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

## **PART 2 - PRODUCTS**

### **2.1 SHEET METAL MATERIALS**

- A. Sheet Metal, General: Provide sheet metal in thick nesses indicated, packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphates finish for exposed surfaces of ducts exposed to view.
- C. Aluminum thickness as described in the contract drawings.

### **2.2 FLEXIBLE CONNECTORS**

- A. General: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- B. Conventional, Indoor System Flexible Connectors Fabric: Glass fabric double coated with polychoroprene:
  - 1. Minimum Weight: 26 oz./square yard
  - 2. Tensile Strength: 480 lb/inch in the warp and 360 lb/inch in the filling.

### **2.3 HANGERS AND SUPPORTS**

- A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
- B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
  - 1. Hangers Installed In Corrosive Atmospheres: Threaded rods that are- Electro-galvanized, all-thread rod or hot-dipped-galvanized, shall be painted after installation.
  - 2. Straps and Rod Sizes: Conform to accepted industry practice for industrial duct construction - IDC-31.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.

## **2.4 RECTANGULAR DUCT FABRICATION**

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
  1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
  2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- B. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
  1. Exhaust Ducts: 2 inches water gage.
- C. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of un-braced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

## **2.5 RECTANGULAR DUCT FITTINGS**

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.

# **PART 3 - EXECUTION**

## **3.1 DUCT INSTALLATION, GENERAL**

- A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.
- B. Install the ducts with the fewest possible joints.
- C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

## **3.2 HANGING AND SUPPORTING**

- A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

- E. Install concrete insert prior to placing concrete.
- F. Install powder actuated concrete fasteners after concrete is placed and completely cured.

### **3.3 CONNECTIONS**

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories."

### **3.4 FIELD QUALITY CONTROL**

- A. The Owner will contract with an independent testing agency to perform, record, and report leakage tests.
- B. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

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**\* END OF SECTION 15891 \***

**\*\* END OF DIVISION 15 \*\***

DIVISION 16  
ELECTRICAL REQUIREMENTS

**SECTION 16-1.1 - ELECTRICAL REQUIREMENTS**

**PART 1 - REQUIRED WORK**

**1.1 STATEMENT OF WORK**

- A The "Electrical Scope" involves: 1) Removal of wiring and conduit, 2) Disconnecting and labeling of all control wires connected to the existing ATS, 3) Installation of temporary E/G and closed transition ATS, and cabling, 4) Install GFE and contractor furnished equipment in accordance with the contract drawings, 5) Wire new power system and control cabling, 6) Identify existing control cable wiring for remote monitoring and remote start and wire to new system, 7) Install ground rods to ground the hoods, exhaust, vent pipes, etc, 8) Remove the new load bank from the e/g to allow for entrance into the door way and reconnect it once the e/g is in place., 9) Perform a number of shutdowns and cutovers, and 10) various other items that are identified in the contract drawings.

**1.2 TEMPORARY POWER/FUEL CONNECTIONS**

- A. Provide and install a temporary E/G, ATS and wire all power and control wiring.  
B. Provide and install temporary power and lights as required.

**1.3 DEMO/REMOVE: (Note: Contractor shall provide the necessary Manifest documents, and the FAA shall provide the proper release documents)**

- A. Demo existing emergency generator and batteries- Dispose of with Manifest  
B. Demo existing automatic transfer switch  
C. Demo existing generator load bank  
D. Demo existing generator bypass switch  
E. Remove various conduits  
F. Remove various other items in the e/g room as shown on the dwgs.

**1.4 INSTALLATION**

- A. New E/G, ATS, and ancillary equipment (GFE)  
B. New E/G load bank (GFE)  
C. Multiple Conduits and cabling,  
D. Penetrations thru building wall  
E. Modify fuel system  
F. Install various other items shown on the contract drawings.

**1.5 TESTING**

- A. Megger checks shall be done with a calibrated meter and shall be documented in copies of Addendum #1  
B. Voltage checks shall be done with a calibrated meter and shall be documented in copies of Addendum #1  
C. Torque requirements of Addendum #1  
D. Testing of the New Kohler E/G and ATS shall be done by a Kohler Technician

\* END OF SECTION 16-1.1 \*

## **SECTION 16-1.2 – REFERENCES**

### **PART 1- GENERAL**

#### **1.1 REFERENCES**

- A. FAA-C-1217F: Federal FAA Specifications for Doing Interior Electrical Work.
- B. FAA-STD-019E: Federal FAA Specifications for Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities.
- C. FAA-C-1391B: Installation and Splicing of Underground Cables
- D. GFE Technical Manuals
- E. NFPA-70: National Electrical Code (NEC)

**\* END OF SECTION 16-1.2 \***

**SECTION 16-1.3 - MATERIAL LIST OF GFE (Government Furnished Materials)****Kohler GFE List:****EG Set for Smith Point TX, VOR Facility**

CLIN	Items	Model	Description
424	GENERATOR	TBD	30 kw,208 volts,3 phase, FIXED DIESEL EG, Rail Mounted radiator ,
481	ATS	TBD	Open Transition ,150amps,208 volts,3 phase
564	LOADBANK	TBD	30 kw,208 volts,3 phase, Exterior Pad mounted ,Automatic and Manual mode
331	DAYTANK	GM19894	120 volts,1 phase,10 gallon,2 GPM (1/3 HP) SP,4 GPM (1/3 HP)
649	MUFFLER	TBD	Critical

**CLIN 424 E/G – Detail**

FAA CLIN 424 30REOZJB				
Kit Descriptions	Kit No	Part No	Part Description	Hyperlink
30 kW, 208 Volts, 3 Phase				
30REOZJB Generator Set	GM38435-C424		Dimension Print	<a href="#">ADV6973</a>
30REOZJB, 12V, 60Hz, Tier II	GM19369-GA10		Dimension Print	<a href="#">ADV6973</a>
Nameplate Rating, Standby	222661			
Voltage, 60Hz, 120/208V, Wye, 3Ph, 4W	333700			
Alternator, 4P5	GM19371-MA4			
Cooling, Unit Mounted Radiator	GM30003-MA1			
Skid, 34"	GM19373-MA1			
Air Intake, Heavy Duty	GM19375-MA2			
Controller, DecMaker550, 12V	GM17425-MA10		Dimension Print	<a href="#">ADV5849</a>
Control & Harness, JD3029	GM19460-MA1			

FAA_CLIN_424_30REOZJB				
Kit Descriptions	Kit No	Part No	Part Description	Hyperlink
Controller Connection Kit	GM17032-KA1			
Block Heater, 1500W, 190-240V	GM19451-KA2			
Isochronous Governor, NonLoadShare, 12V	GM17725-KA1			
Run Relay, 12V	273743			
Failure Relay w/Harness, 1Fault	GM17032-KA2			
Shunt Trip Wiring, 20-60 kW FAA	GM17032-KA6			
Line Circuit Breaker, Dual 125/100 A	GM19518-KA1	GM19518	Drawing Assembly	<a href="#">GM19518</a>
Line Circuit Breaker, Dual 125/100 A	GM19518-KA1	X-6304-151	Breaker, Circuit 80A	<a href="#">X6304</a>
Line Circuit Breaker, Dual 125/100 A	GM19518-KA1	X-6304-60	Breaker, Circuit 100A 600V	<a href="#">X6304</a>
Flexible Fuel Lines	GM19461-KA2	273631	Fuel line	<a href="#">324101</a>
Flexible Fuel Lines	GM19461-KA2	324608	Fuel line, flexible	<a href="#">273614</a>
Flexible Fuel Lines	GM19461-KA2	GM21201	Fuel line, flexible	<a href="#">273614</a>
Fuel Pressure Gauge	352374			
Air Cleaner Restriction Indicator	274608			
Closed Crankcase Vent, HDAC	GM20695-KA4			
Turbo Manifold Pressure Gauge	GM23251-KA1			
Dimension Print, 20-30 REOZJB	ADV-6973			
Load Bank	GM38406-KA4			
Literature FAA CLINs 423-424	701-184-231-FAA		FAA P/C X-Ref, 20-100REOZJ, Clins C421-C427, C431, C433, C435, C437, C439, C441, C443	<a href="#">FB10</a>
Literature FAA CLINs 423-424	701-184-231-FAA		S/S 30REOZJB, Diesel, Industrial	<a href="#">G5203</a>
Literature FAA CLINs 423-424	701-184-231-FAA		S/S Controller, Decision-Maker 550	<a href="#">G6046</a>
Literature FAA CLINs 423-424	701-184-231-FAA		S/S Communications, Decision-Maker 550	<a href="#">G6050</a>
Literature FAA CLINs 423-424	701-184-231-FAA		S/M FRII, 20-300 kW, Industrial	<a href="#">TP5353</a>
Literature FAA CLINs 423-424	701-184-231-FAA		P/C 20ROZJB/20-230REOZJB/80-180REOZJC	<a href="#">TP6142</a>



FAA_CLIN_424_30REOZJB				
Kit Descriptions	Kit No	Part No	Part Description	Hyperlink
Literature FAA CLINs 423-424	701-184-231-FAA		P/C 20-40 kW John Deere 3029DF/TF	<a href="#">TP6141</a>
Literature FAA CLINs 423-424	701-184-231-FAA		I/M Industrial	<a href="#">TP5700</a>
Literature FAA CLINs 423-424	701-184-231-FAA		O/M 20-2000 kW, DecMaker550, Ver 2.10	<a href="#">TP6200</a>
Literature FAA CLINs 423-424	701-184-231-FAA		O/M John Deere 3029	<a href="#">TP6144</a>
Literature FAA CLINs 423-424	701-184-231-FAA		S/M John Deere 3029	<a href="#">TP6145</a>
Literature FAA CLINs 423-424	701-184-231-FAA		O/M John Deere Engine Service Supplement	<a href="#">TP5889</a>
Literature FAA CLINs 423-424	701-184-231-FAA		P/C Accessories, 20-230 kW Diesel, Ind	<a href="#">TP6116</a>
Literature FAA CLINs 423-424	701-184-231-FAA		W/D CLINS 421-466, FAA	<a href="#">TP6299</a>
Literature FAA CLINs 423-424	701-184-231-FAA		TT Float/Equalize Batter Charger, Ind	<a href="#">TT680</a>
Literature FAA CLINs 423-424	701-184-231-FAA		TT Run Relay, 20-1600 kW	<a href="#">TT700</a>
Literature FAA CLINs 423-424	701-184-231-FAA		TT Crct Bd, Float/Equalize Btry Chrgr	<a href="#">TT729</a>
Literature FAA CLINs 423-424	701-184-231-FAA		TT Battery Activation, 6-2800 kW	<a href="#">TT796</a>
Literature FAA CLINs 423-424	701-184-231-FAA		TT Remote Emergency Stop, 6-1600 kW	<a href="#">TT940</a>
Literature FAA CLINs 423-424	701-184-231-FAA		TT Day Tank, Diesel, Industrial	<a href="#">TT671</a>
SILENCERS TABLE				<a href="#">Silencers</a>
KITS SHIPPED LOOSE WITH CLIN				
Flexible Exhaust Conn. 3"NPT	GM19877-KP1	GM19876	Adapter, Flex Exhaust	<a href="#">273671</a>
Battery, 2/12V, 650CCA, Dry	PA-225290 (QTY 2)	225289	Battery, dry charged (12V, 650 CCA)	<a href="#">244578</a>
Battery Charger, Float w/Alarms, 12V-10A	PAA-326766	A-326766	TT Float/Equalize Batter Charger, Ind	<a href="#">TT680</a>
Remote Emergency Stop Switch	PA-293906	A-222654	TT Remote Emergency Stop, 6-1600 kW	<a href="#">TT940</a>
Exhaust Manifold & Turbo Blanket	GM21241-KP2	GM21242	Insulating blanket kit (JD 20-40kW)	<a href="#">GM21241</a>
Free Standing Battery Rack	GM38385-KP1		Dwg, Assy 12V FAA Battery Rack	<a href="#">GM38385</a>

FAA_CLIN_424_30REOZJB				
Kit Descriptions	Kit No	Part No	Part Description	Hyperlink
Load Bank Controller	PA-354753	354743	Controller, load bank	<a href="#">326773</a>
WIRING DIAGRAM				
Decision Maker 550 Controller and EG Interconnections			Diagram, Wiring	<a href="#">GM38365</a>
NOTES:				
Hand Fuel Primer Pump is Standard				

**CLIN 481 ATS- Detail**

FAA_ATS_CLIN_481			
Part No.:	GM34368-C481		
CLIN:	481		
Amps:	150		
Voltage:	208		
Phase:	3		
Transition:	Open		
Detail Information			
Material	Description	Qty	
COMPLETE SPEC			
GM34368-C481	FAA-ATS ZCM-568641-0150		
COMPLETE SPEC INCLUDES			
KZATS	ZCM-568641-0150	1	
DD-18-JD2	Meter, Volt/Amm, 190-240V	1	
DD-34-A	Source Monitor, Inphase	1	
DD-34-J	Source Monitor, Over/Under Volt & Freq	1	
DD-34-Z	Source Monitor, Phase Rotation	1	
DD-5-K	Source Monitor, 3 Ph, Emergency	1	
DD-51-A	RS-485 Communication Module	1	
DD-6-P	Test Switch, 3 Position	1	

DD-8-C	Time Delay Override Sw, Emerg to Normal	1	
PA-353664	Lit Kit, ATS Prod, Model ZCB (Logic 5,6)	2	
PA-353665	Lit Kit, ATS Ovhl, Model ZCB (Logic 5,6)	2	
NOTES			
Auxiliary Contacts	Closed in Normal	4	
Auxiliary Contacts	Closed in Emergency	4	
SUBMITTAL DRAWINGS			
Schematic			<u>321469</u>
Wiring Diagram			<u>321474</u>
Dimension			<u>ADV5958</u>
LITERATURE KIT (701-30-1009-FAA) INCLUDES			
Warranty, 1-Year Limited, ATS			<u>TP5373</u>
O/I/M M340+ Logic ATS			<u>TP5664</u>
O/I/M ZCM/ZCB BIS Power Conversion, ATS			<u>TP5665</u>
S/P ZCB/ZCM/ZCS/KBL/KCL Contactor Power Conversion, ATS			<u>TP5668</u>
S/P/M M340+ Logic, ATS			<u>TP5672</u>
S/S M340+ Controls, ATS			<u>G1156</u>
S/S ZCM/ZCB, Bypass Isolation Switch,ATS			<u>G1157</u>

**\* END OF SECTION 16-1.3 \***

## **SECTION 16-1.4 - EQUIPMENT INSPECTION**

### **PART 1 – GENERAL**

#### **1.1 REQUIREMENTS**

- A. Unpack and inspect the equipment for damage and for equipment verification with the actual ordering documentation. Manufacturer's installation and planning documentation should be provided with the GFE Equipment. All equipment must be inspected and the shipping slips must be verified with each crate within 5- days of delivery. If any of the components are damaged or missing, provide a list of the items to the COTR in writing immediately.

**\* END OF SECTION 16-1.4 \***

**SECTION 16-1.5 - CUTOVER PLANS (See Addendum #2)****\* END OF SECTION 16-1.5 \*****SECTION 16-1.6 - LABEL PLATE TABLE (1)**

(Label plates shall be made of Black Phenolic material using white lettering on a black background with double back tape on the back of the label plate.)

\* Verify the CB breaker designation prior to manufacturing label plates.

<b><u>QTY</u></b>	<b><u>DESCRIPTION</u></b>	<b><u>SIZE</u></b>	<b><u>LOCATION</u></b>
1	ATS Fed From the E/G and Main Disconnect Switch	4" X 4"	ATS-E/G Room
1	Engine Generator Room Power Panel 100Amp, 120/208 Volt Fed From ATS	4" X 4"	Engine Room Power Panel-E/G Room
1	Exhaust Fan Thermostat Fed from E/G Power Panel CB #1	2" X 2"	Exhaust Fan Thermostat-E/G Building

**\* END OF SECTION 16-1.6 \***

## **SECTION 16-1.7 - EQUIPMENT GROUNDING CONDUCTOR**

### **1.1 SIZE**

- A. All metallic non-current carrying parts of the electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated. When these conductors are not sized or shown on the drawings, they shall be sized in accordance with the NEC. These conductors shall not be smaller than #12 wires.

### **1.2 CONNECTIONS**

- A. Equipment grounding conductors shall be connected to the grounded conductor (neutral) only at the service disconnecting means and at separately derived systems. This connection is sometimes called the main bonding jumper. The equipment grounding conductor shall be installed in the same conduit as its related branch and feeder conductors and shall be connected to the ground bus in the branch or distribution panel board.

### **1.3 INSTALLATION**

- A. Each individual feeder and branch circuit shall have its own equipment grounding conductor regardless of whether the circuit is in its own raceway or in a raceway containing other similar circuits. A full sized equipment grounding conductor shall be installed in each raceway and it must be insulated and color coded green. Metal conduit housing the equipment grounding conductor shall be electrically continuous, forming a parallel path to the equipment grounding conductor. Under no circumstances shall the equipment grounding conductor be omitted from the electrical system, nor shall any separate grounding system such as the electronic signal ground or direct connections to the earth grounding system, be used for an alternate grounding system or an alternate path to the grounding electrode. All connections to equipment to be grounded shall be made with a grounding connector specifically intended for that purpose. Bare wire, wrapped around connecting screws or mounting bolts and screws, is not acceptable as a grounding connection. All ground lugs shall be of a non-corrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc.

**\*END OF SECTION 16-1.7 \***

## **SECTION 16-1.8 - WIRING METHODS**

### **1.1 GENERAL**

- A. Unless otherwise indicated, wiring shall consist of insulated copper conductors installed in conduit. In single-phase systems (120 volt, two wire and 120/240 volt, 3 wire), one grounded conductor (neutral) shall accompany each ungrounded phase conductor (120 volt systems) or ungrounded phase conductor pair (120/240 volt systems) powered from a circuit interrupting device. In three-phase, wye, 4 wire systems, one grounded conductor (neutral) shall accompany the three related ungrounded conductors fed from a circuit interrupting device. All neutral conductors shall extend from the neutral bus in the device where the active conductors originate. Device terminals for connection of more than one conductor shall be specifically designed for that purpose.

### **1.2 ELECTRICAL METALLIC TUBING (EMT)**

- A. EMT may be used only in dry interior locations, and where not subject to physical damage. EMT shall not be used on circuits above 600 volts or in sizes greater than 4 inches in diameter. Fittings used with EMT shall be standard compression-type fittings designed for this type of conduit, unless otherwise indicated. Screw-type fittings are not acceptable. Where conduits enter enclosures without threaded hubs, an appropriate connector with threads and locknut shall be used to securely bond the conduit to the enclosure. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure. In addition, the connectors shall be the insulated-throat type.

### **1.3 INSTALLATION OF CONDUIT (EMT)**

- A. EMT shall be mechanically and electrically continuous between outlet, junction and pull boxes, panels, cabinets, and similar equipment. Conduit connections are to be made with compression type fittings.
- B. Conduits shall enter and be secured to enclosures so that each system is electrically continuous throughout.
- C. Where knockouts are used, provide double locknuts, one on each side, with a grounding bushing on the inside.
- D. Install the complete conduit run before pulling in the conductors.
- E. Field made bends and offsets shall be made with an approved hickey or conduit bending machine. Crushed, dented or deformed raceways and bends are not acceptable. Use no more than equivalent of four 90 degree bends in any run between pulling points. Inside radii of bends in conduits one inch size or larger shall not be less than ten times the nominal diameter.
- F. EMT shall be supported in accordance with the NEC. Support the conduit at a maximum of 10 foot intervals and within three feet of boxes or equipment. Fasten conduit support members from the building structure. Include steel channels, stems, mounting brackets and anchors. Conduit supports shall employ materials which are suitable for the purpose.
- G. Pull Wire shall not be less than 14awg zinc coated steel or plastic with a minimum 200 pound tensile strength. Provide a minimum of ten inches of slack at each end of the pull wire.

**\* END OF SECTION 16-1.8 \***

**SECTION 16-1.9 - CONDUCTORS****PART 1 - GENERAL****1.1 INSULATED CONDUCTORS**

- A. Unless otherwise indicated, insulated conductors shall be copper with thermoplastic or thermosetting insulation, type THHN for use in dry locations only. The conductors must be insulated for 600 volts in accordance with Federal Specification J-C-30. Unless otherwise indicated, conductors no.10awg and smaller shall be solid (unstranded), and conductors no. 8 awg and larger shall be stranded. Minimum branch circuit conductor size shall be no. 12 awg. Minimum control wire size shall be no. 14 awg unless noted otherwise.

**1.2 MARKING**

- A. Each wire and cable shall be marked at the factory to show size, voltage, rated temperature, type, and manufacturer, in accordance with the NEC.

**1.3 COLOR CODING**

- A. Provide conductors having insulation colored continuously throughout when factory colored conductors are not available, color code in field as specified.  
 B. Use green colored insulation for the equipment grounding conductor.  
 C. Power conductors shall be color coded as follows:

<b>Single Phase 120 volts</b>	<b>Single Phase 120/208 volts</b>	<b>Three Phase 120/208 volts</b>
Line- Black Neutral – White	Line 1 - Black Line 2 -Red Neutral - White	Phase A - Black Phase B - Red Phase C - Blue Neutral - White

Note: For conductors where color coding is not available, color coded tape half lapped for a minimum length of 3 inches shall be used. Where conductors are color coded in this manner, they shall be color coded in all junction boxes and pull boxes accessible raceways, panel boards, outlets, and switches, as well as at all terminations.

**1.4 APPEARANCE**

- A. Neatly and securely bundle all cable or conductors in an enclosure using nylon straps.

**1.5 BOLTED TYPE CONNECTIONS**

- A. Clean contact surfaces with nonabrasive cleaner before making connections. Tighten bolts with a torque wrench in accordance with the manufacturer's recommendations.

**\* END OF SECTION 16-1.9 \***



**SECTION 16-1.10 - BOXES**

**PART 1 – GENERAL**

**1.1 REQUIREMENTS**

- A. Boxes shall be either the cast-metal threaded-hub type conforming to Federal Specification W-C-586, galvanized steel type conforming to Federal Specification W-J-800, or metal outlet boxes conforming to NEMA OS 1. Cast aluminum boxes shall be used only with aluminum conduit. Where not sized on the drawings, boxes shall be sized in accordance the NEC.

**\* END OF SECTION 16-1.10 \***

## **SECTION 16-1.11 – SUPPORTS**

### **PART 1 – GENERAL**

#### **1.1 REQUIREMENTS**

- A. Boxes and supports shall be fastened to wood with wood screws, nails, or screw-type nails of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Threaded studs driven by powder charge and provided with lock washers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. In separately supported except where used for fixture support; cast-metal boxes having thread less connectors and sheet-metal boxes shall be supported directly from the building structure or by bar hangers. Where bar hangers are used, raceway shall be supported with an approved fastener not more than 24 inches from the box. Penetration shall be no more than 1 1/2 inches into reinforced concrete beams or more than 3/4 inch into reinforced concrete joints. Main reinforcing steel shall not be cut.

**\* END OF SECTION 16-1.11 \***

## **SECTION 16-1.12 – RECEPTACLES**

### **PART 1 – GENERAL**

#### **1.1 REQUIREMENTS**

- A. Receptacles shall be of the voltage and current rating indicated on the drawings. All receptacles shall be specification grade in accordance with NEMA STD WD-1. Wiring terminals shall be of the screw - type. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable. Unless noted otherwise, receptacles shall be installed 12 inches above the finished floor. All receptacles, unless they are of the isolated - ground type, shall be grounded by the installation of a green grounding pigtail from the receptacle grounding screw directly to the grounding lug on the outlet box where the green equipment grounding conductor is terminated. The equipment grounding conductor shall be installed with the receptacle power conductors and shall terminate at the ground bus in the electrical service panel. The receptacles must be heavy duty, general use, and brown bodies of fire resistant, no absorptive, thermosetting phenolic compound.

**\* END OF SECTION 16-1.12 \***

## SECTION 16-1.13 - TESTING

### PART 1 – GENERAL

#### 1.1 REQUIREMENTS

- A. Unless otherwise indicated, the contractor shall furnish all test instruments, materials and labor necessary to perform the following tests. All tests shall be performed in the presence of the contracting officer or his designated representative. All instruments shall have been calibrated within a period of two years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.

#### 1.2 CABLES

- A. All cables shall be tested prior to installation and again upon completion of the installation. All testing shall be accomplished before connection is made to any existing equipment.

#### 1.3 INSULATION RESISTANCE TESTS

- A. Feeder and branch circuit insulation tests shall be performed after installation, but before connection to fixtures or appliances. All conductors shall test free from short circuits and grounds, and have a minimum phase - to -phase and phase- to -ground insulation resistance of **30 megohms for 30 seconds, when measured with a 500 - volt DC** insulation resistance tester. The contractor shall submit a letter type test report to the COTR prior to final FAA inspection of the contractor's work. The report shall list the tests performed and results obtained.

**\* END OF SECTION 16-1.13 \***

**SECTION 16-1.14 - OPERATIONAL TEST**

**PART 1 – GENERAL**

**1.1 REQUIREMENTS**

- A. After the interior wiring system installation is completed, and at such time as the COTR may direct, the contractor shall conduct an operational test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the COTR or designated representative.

**\* END OF SECTION 16-1.14 \***

## SECTION 16-1.15 - ADDENDUM (#1)

FAA Form 16010 -1

**ELECTRICAL TEST REPORT**

(\*Make as many copies as required and fill in the appropriate blocks

\*\* Make sure cables are disconnected prior to the Meg test)

				<b>Date:</b>		<b>Sheet No. 1</b>		<b>of</b> _____	
<b>Project Name:</b> VOR				<b>Address</b>		Smith Point, TX			
				<b>:</b>					
<b>Project No.</b>		E/G							
Service Transformer Size	N/A			N/A			N/A		
NL Service Voltage	N/A			N/A			N/A		
FL Service Voltage	N/A			N/A			N/A		
Panel or SWBD Served from	200Amp Main Disconnect			E/G			ATS		
Measurement Location	ATS			ATS			Panel "A"		
Type	THHN			THHN			THHN		
Feeder O C Protection	125 amp			100Amp			100Amp		
Feeder Conductor Size	#1 AWG			#1 AWG			#1 AWG		
	<b>PHASE</b>			<b>PHASE</b>			<b>PHASE</b>		
<b>Measured Conditions</b>	<b>A-B</b>	<b>A-C</b>	<b>B-C</b>	<b>A-B</b>	<b>A-C</b>	<b>B-C</b>	<b>A-B</b>	<b>A-C</b>	<b>B-C</b>
No Load Feeder Voltage									
Operator Load Feeder Voltage									
Operating Load Current									
Conductor Insul. Resistance @ AB		***** *****	***** *****		***** *****	***** *****		***** *****	***** *****
Conductor Insul. Resistance @ AC	***** *****		***** *****	***** *****		***** *****	***** *****		***** *****
Conductor Insul. Resistance @ BC	***** *****	***** *****		***** *****	***** *****		***** *****	***** *****	
<b>Phase:</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>A</b>	<b>B</b>	<b>C</b>
Conductor Insul. Resistance to Grd.									
<b>Neutral:</b>	<b>N-G</b>	*****	***** *	<b>N-G</b>	***** *	*****	<b>N-G</b>	***** *	***** *
Neutral Insul. Res. To Grd. w/ Grd. Conn. Removed		***** *****	***** ***** **		***** ***** **	*****		***** ***** **	***** ***** **

FAA Form 16010 -1

**TORQUE RECORD****PROJECT LOCATION:** Smith Point TX VOR E/G Replacement**DATE:** \_\_\_\_\_**TORQUE WRENCH SERIAL #:** \_\_\_\_\_**TORQUE WRENCH CALIBRATION EXP. DATE:** \_\_\_\_\_**TORQUED BY:** \_\_\_\_\_**WITNESS BY:** \_\_\_\_\_**TORQUE RECORD**

<b><u>EQUIPMENT</u></b>	<b><u>LUG LOCATION</u></b>	<b><u>NUMBER OF LUGS</u></b>	<b><u>LUG TORQUE SETTING REQUIRED</u></b>	<b><u>INITIALS AND DATE</u></b>
ATS	Normal Power Input			/
ATS	Emergency Power Input			/
ATS	Output/Load			/
E/G	Output Breaker			/
E/G	Load Bank Breaker	N/A	N/A	/
Load Bank	Load Bank	N/A	N/A	/
				/
				/
				/
				/
				/
				/
				/
				/

\*Use manufacturer instructions for establishing Torque requirements.

**\* END OF SECTION 16-1.15 \***

**SECTION 16-1.16 - ADDENDUM (#2)****1.0 PHASE I: ENGINE GENERATOR (E/G) CUTOVER PLAN**

(Note: a) All de-energizing of power circuits in the facility shall be done by the FAA.

b) The contractor may need to provide temporary lighting during cutovers.

c) This is a recommended cutover plan, however due to field conditions it may vary.)

**1.1 TEMP E/G SETUP: (Work Hours to be determined prior to pre-con)**

- 1.1.1. The contractor shall provide the temp E/G , ATS, Fuel and all wiring for the temporary power service.
- 1.1.2. Perform voltage and phase rotation measurements at panel "A" prior to disconnecting power. Voltage: AB: \_\_\_\_\_, AC \_\_\_\_\_, BC \_\_\_\_\_  
Phase Rotation: \_\_\_\_\_, FAA RE Sign/Date: \_\_\_\_\_
- 1.1.3. Start the Temp E/G before it is wired to ensure it operates properly.
- 1.1.4. Setup the temporary power system and route the temporary cables such that once the facility is de-energized the conductors can be connected in a short amount of time. The cables are to be routed through the existing Air Intake in the e/g room and an existing penetration into the electronics room.
- 1.1.5. Shut down the system, by having the FAA shut down the equipment by opening the breakers in Panel "A" and tagging open the main disconnect switch to the facility. Disable the existing ATS and E/G so that the existing E/G does not start once there is loss of power.
- 1.1.6. Connect the temp E/G and ATS power and control cabling and remove the tag from the main disconnect switch so that Normal power is being fed to the ATS. Verify the voltage and phase rotation at Panel "A". Voltage: AB: \_\_\_\_\_, AC \_\_\_\_\_, BC \_\_\_\_\_; Phase Rotation: \_\_\_\_\_, FAA RE Sign/Date: \_\_\_\_\_  
This should be the same as in section 1.1.2.
- 1.1.7. Perform a simulated power outage by opening the main disconnect switch and verifying the e/g starts automatically. Verify the voltage and phase rotation at Panel "A": Voltage: AB: \_\_\_\_\_, AC \_\_\_\_\_, BC \_\_\_\_\_; Phase Rotation: \_\_\_\_\_, FAA RE Sign/Date: \_\_\_\_\_
- 1.1.8. Close the Main disconnect switch and verify that normal power is transferred back and that the temp e/g shuts down.
- 1.1.9. Close the breakers in Panel "A" and verify that all the VOR equipment is back on line. FAA RE Sign/Date: \_\_\_\_\_
- 1.1.10. Now the facility is on Temporary backup power and the removal of the existing emergency power system may begin.

**1.2 Remove Existing E/G & Installation of New E/G: (Work Hours during the Day)**

- 1.2.1 Remove and dispose of the existing E/G and ancillary components as shown in the contract dwgs and from the site visit.
- 1.2.2 Install the mechanical fuel piping as shown in the contract drawings.
- 1.2.3 Perform wall penetrations and cutouts for the mechanical systems.
- 1.2.4 Install the hoods and louvers
- 1.2.5 Connect all control wiring and power wiring.
- 1.2.6 Contractor must provide all fluids for the Engine Generator including the battery acid for the E/G batteries.
- 1.2.7 Perform megger tests on all power cables to and from the ATS in accordance with Electrical Test report document in this spec. Fill out the appropriate circuit being tested. Ensure that the cabling is not connected to the equipment during the testing.



- 1.2.8 Perform Torque tests in accordance with Torque Test table in this specification. Use the manufacturer's specifications to determine the required Torque requirements.
- 1.2.9 Once the E/G is wired and has been inspected by the FAA, coordinate the startup with Kohler.

### **1.3 TEST and Cutover New E/G System:**

- 1.3.1 Once the new E/G is installed the FAA RE must coordinate with the Kohler Tech to perform the startup services. Notify the local FAA so they can coordinate personnel to witness the testing.
- 1.3.2 Once Kohler has completed its cold checks, shut down the main power feed by tagging out the 200amp main disconnect switch. Verify there is no power on the main input of the temporary ATS. (The temp E/G will start and provide power to the facility.) (Note: The other option is to have an outage and remove the normal power from the temp ATS and then have the temp e/g provide power to the facility without a normal source.)
- 1.3.3 Disconnect the main power feed to the temporary ATS and connect the new cabling from the New ATS to the Main Disconnect. (Note: At this time the temp E/G will be running and providing power to the facility.)
- 1.3.4 Once the cable is connected, close the 200amp Main Disconnect and verify voltage and Phase rotation at the new ATS. Voltage: AB: \_\_\_\_\_, AC \_\_\_\_\_, BC \_\_\_\_\_: Phase Rotation: \_\_\_\_\_, FAA RE Sign/Date: \_\_\_\_\_  
This should be the same as in paragraph 1.1.7.
- 1.3.5 Kohler representative may continue testing after all connections have been made.
- 1.3.6 Once testing is done on the Kohler E/G and the load test is completed satisfactory, a **facility shutdown is required. Tag open the breakers in Panel "A".** Shut down and disconnect the temporary E/G. Ensure the New E/G breaker is open, the Main Disconnect Switch is tagged open and that the ATS is de-energized. Connect the output of the new ATS to Panel "A". Once the connections are made and the megger tests are satisfactory, energize the input to Panel "A" by closing the 200amp main disconnect switch and closing the e/g main breaker.
- 1.3.7 Verify voltage and Phase rotation at the input to Panel "A": Voltage: AB: \_\_\_\_\_, AC \_\_\_\_\_, BC \_\_\_\_\_: Phase Rotation: \_\_\_\_\_, FAA RE Sign/Date: \_\_\_\_\_  
This should be the same as in paragraph 1.1.7.
- 1.3.8 Once the ATS is fully energized, the Kohler technician must perform the checks on the ATS system. Once the testing is completed satisfactory, it is time to switch over the load and close the main breaker in Panel "A".
- 1.3.9 Once the entire facility is on the new E/G and ATS system, perform a facility load test as follows. Place all the VOR equipment back on line. Simulate the loss of power by opening the Main Disconnect switch. Once the test is complete and meets the Kohler test procedure, close the Main Disconnect switch and verify that the system switches over to normal power. FAA verify that the system operates properly and that there is no loss of power to the FAA electronics equipment: FAA RE Sign/Date: \_\_\_\_\_

**\* END OF SECTION 16-1.16 \***

**\*\* END OF DIVISION 16 \*\***